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REMARKS/ARGUMENTS

Claims 13-22 are pending in this application. By this Amendment, Applicant AMENDS the title of the invention, CANCELS claims 1-12, and ADDS claims 13-22.

Claims 10-12 were rejected under 35 U.S.C. § 112, second paragraph as allegedly being indefinite. The Examiner alleged that the “second specified angle” recited in claims 10 and 11 should be a “second specified value” as the increase rate is a value, not an angle. Applicant has canceled claims 10-12. Accordingly, Applicant respectfully submits that the rejection of claims 10-12 under 35 U.S.C. § 112, second paragraph, is moot.

Claims 1-9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Raichle et al. (U.S. 2002/0021120). Applicant notes that the Examiner did not reject claims 10-12 over prior art, nor did the Examiner indicate whether claims 10-12 are allowable over the prior art of record.

Applicant has canceled claims 1-12 and added new claims 13-22.

New claim 13 recites:

An engine control system comprising:  
an ion current measuring unit arranged to measure a negative ion current in a combustion chamber of an engine;  
a crank-angle measuring unit arranged to measure an engine crank angle;  
and  
a controller comprising:  
**means for determining a first crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the first crank angle being a crank angle corresponding to a rising point of the negative ion current at or above a first specified value on a negative ion current curve indicative of variations in negative ion current relative to crank angles;**

**means for determining a second crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the second crank angle being a crank angle corresponding to a peak point of the negative ion current on the negative ion current curve;**

**means for calculating a substantial middle point between the first crank angle and the second crank angle as a third crank angle corresponding to a combustion center of gravity; and**

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means for controlling an engine ignition timing so that the third crank angle approximates a desired target crank angle. (emphasis added)

Applicant's claims 19-22 recite features and method steps that are similar to the features recited in Applicant's claim 13, including the above-emphasized features.

With the unique combination and arrangement of features recited in Applicant's claim 13, and similarly in Applicant's claims 19-22, including the features of "means for determining a first crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the first crank angle being a crank angle corresponding to a rising point of the negative ion current at or above a first specified value on a negative ion current curve indicative of variations in negative ion current relative to crank angles," "means for determining a second crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the second crank angle being a crank angle corresponding to a peak point of the negative ion current on the negative ion current curve," and "means for calculating a substantial middle point between the first crank angle and the second crank angle as a third crank angle corresponding to a combustion center of gravity," Applicant has been able to provide a system or method capable controlling ignition timing to better agree with Maximum Best Timing (MBT) over a wide range of operating conditions to thereby increase fuel efficiency, reduce exhaust gas, and/or improve drivability without measuring torque and combustion pressure (see, for example, paragraph [0006] of Applicant's substitute specification).

The Examiner alleged that Raichle et al. teaches all of the features recited in Applicant's claim 1, including an ion current measuring unit 24, a crank angle measuring unit 23, and a controller 23. The Examiner further alleged that the functions of the controller "have not been given any patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language" (see, for example, section k on page 4 of the outstanding Office Action).

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Applicant has canceled claim 1 and added new independent claims 13 and 19-22, in which apparatus claims 13, 19, and 20 recite structure to perform the claimed functions. The Examiner is required to give weight to the functional recitations because courts do not regard the fact that a claim is functional as good ground to give such recitations “no weight” in view of the third paragraph of 35 U.S.C. §112. In re Land & Rogers, 151 USPQ 621 (CCPA 1966).

Support for the features recited in new claim 13, and similarly new claims 19-22, can be found in, for example, Applicant’s original claim 1, and similarly Applicant’s original claims 7, 8, 10, and 11, and paragraphs [0035] and [0038] of Applicant’s substitute specification. Support for new claims 14, 15, 17, and 18 can be found in, for example, Applicant’s original claims 4-6 and 9. Support for new claim 16 can be found in, for example, paragraph [0040] of Applicant’s substitute specification.

In contrast, Raichle et al. teaches a very different and very complicated process for determining the combustion center of gravity. Furthermore, the combustion center of gravity disclosed by Raichle et al. is different from the combustion center of gravity according to Applicant’s claims 13 and 19-22.

First, Raichle et al. teaches conditioning the measured ion current signal I to separate a first part (offset stream) from a second part (useful information) (step 1, paragraphs [0015]-[0018] of Raichle et al.), calculating the center of gravity of an area (step 13), subjecting the result to a plausibility test (step 14), averaging the results of an appropriate number of working cycles (step 15), and providing a correction with the aid of a characteristics map (step 16) (see, for example, paragraphs [0037] and [0038] of Raichle et al.). The process for calculating a combustion center of gravity disclosed by Raichle et al. is very complicated and includes many different steps.

Second, the combustion center of gravity Y corresponds to a point slightly after a peak of the ion current signal I is detected (see, for example, Fig. 3 and paragraph [0045] of Raichle et al.). Raichle et al. does not remotely teach or suggest calculating a substantial middle point between a start of combustion X and the peak of combustion Y as determined by the detected ion current signal, and certainly does not teach or

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suggest that the middle point between the start of combustion X and the peak of combustion Y, as determined by the detected ion current signal, is the combustion center of gravity.

Thus, Raichle et al. clearly fails to teach or suggest the features of “means for determining a first crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the first crank angle being a crank angle corresponding to a rising point of the negative ion current at or above a first specified value on a negative ion current curve indicative of variations in negative ion current relative to crank angles,” “means for determining a second crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the second crank angle being a crank angle corresponding to a peak point of the negative ion current on the negative ion current curve,” and “means for calculating a substantial middle point between the first crank angle and the second crank angle as a third crank angle corresponding to a combustion center of gravity,” as recited in Applicant’s claim 13, and similarly in Applicant’s claims 19-22.

Accordingly, Applicant respectfully submits that any rejection of claims 13 and 19-22 under 35 U.S.C. § 103(a) as being unpatentable over Raichle et al. would be improper for at least the reasons above.

Applicant’s new claim 19 recites:

An engine control system comprising:  
an ion current measuring unit arranged to measure a negative ion current in a combustion chamber of an engine;  
a crank-angle measuring unit arranged to measure an engine crank angle;  
and  
a controller comprising:

means for determining a first crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the first crank angle being a crank angle corresponding to a rising point of the negative ion current at or above a first specified value on a negative ion current curve indicative of variations in negative ion current relative to crank angles;

means for determining a second crank angle based on the negative

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ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the second crank angle being a crank angle corresponding to a peak point of the negative ion current on the negative ion current curve;

means for calculating a substantial middle point between the first crank angle and the second crank angle as a third crank angle corresponding to a combustion center of gravity;

**means for calculating a variation rate of the third crank angle;**  
and

**means for controlling an exhaust gas recirculation rate of the engine so that the exhaust gas recirculation rate decreases when the variation rate increases.** (emphasis added)

With respect to original claim 7, the Examiner alleged that the recitations of the “controller adapted to calculate a variation rate of the third crank angle” and “the controller is adapted to control an exhaust gas recirculation (EGR) rate” are narrative in form and have not been given any patentable weight.

Applicant’s new claim 19, which includes features similar to the features recited in Applicant’s original claim 7, recites the features of “means for calculating a variation rate of the third crank angle” and “means for controlling an exhaust gas recirculation rate of the engine so that the exhaust gas recirculation rate decreases when the variation rate increases.” Support for these features is found, for example, in Applicant’s original claim 7 and paragraph [0052] of Applicant’s substitute specification.

Applicant’s new claim 20 recites:

An engine control system comprising:

an ion current measuring unit arranged to measure a negative ion current in a combustion chamber of an engine, the engine having an intake valve and an exhaust valve;

a crank-angle measuring unit arranged to measure an engine crank angle;  
and

a controller comprising:

means for determining a first crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the first crank angle being a crank angle corresponding to a rising point of the negative ion current at or above a first specified value on a negative ion current curve indicative of variations in negative ion current relative to crank angles;

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means for determining a second crank angle based on the negative ion current measured by the ion current measuring unit and the engine crank angle measured by the crank-angle measuring unit, the second crank angle being a crank angle corresponding to a peak point of the negative ion current on the negative ion current curve;

means for calculating a substantial middle point between the first crank angle and the second crank angle as a third crank angle corresponding to a combustion center of gravity;

**means for calculating a variation rate of the third crank angle;  
means for controlling an open-close timing of the intake valve  
and the exhaust valve so that an overlap period of the intake valve and the  
exhaust valve decreases as the variation rate increases.** (emphasis added)

With respect to original claim 8, the Examiner alleged that the recitations of the “controller adapted to calculate a variation rate of the third crank angle” and “the controller is adapted to control an open-close timing of an intake valve and the exhaust valve” are narrative in form and have not been given any patentable weight.

Applicant’s new claim 20, which includes features similar to the features recited in Applicant’s original claim 8, recites the features of “means for calculating a variation rate of the third crank angle” and “means for controlling an open-close timing of the intake valve and the exhaust valve so that an overlap period of the intake valve and the exhaust valve decreases as the variation rate increases.” Support for these features is found, for example, in Applicant’s original claim 8 and paragraphs [0053] and [0054] of Applicant’s substitute specification.

In contrast, Raichle et al. specifically teaches discarding fluctuations of the combustion center of gravity that are outside a plausible range, and averaging the remaining combustion center of gravity values to compensate for the fluctuations (see, for example, paragraph [0042] of Raichle et al.). That is, Raichle et al. does not track or calculate a rate of the fluctuations but instead deliberately discards large fluctuations. Consequently, Raichle et al. cannot possibly teach controlling an exhaust gas recirculation rate or open-close valve timing based on the fluctuation rate.

Thus, in addition to the features discussed above with respect to claim 13, Raichle et al. also clearly fails to teach or suggest the features of “means for calculating

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a variation rate of the third crank angle" and "means for controlling an exhaust gas recirculation rate of the engine so that the exhaust gas recirculation rate decreases when the variation rate increases," as recited in Applicant's claim 19, or the features of "means for calculating a variation rate of the third crank angle" and "means for controlling an open-close timing of the intake valve and the exhaust valve so that an overlap period of the intake valve and the exhaust valve decreases as the variation rate increases," as recited in Applicant's claim 20.

Accordingly, Applicant further respectfully submits that any rejection of claims 19 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Raichle et al. would be improper for at least the reasons above.

In view of the foregoing amendments and remarks, Applicant respectfully submits that claims 13 and 19-22 are allowable. Claims 14-18 depend upon claim 13, and are therefore allowable for at least the reasons that claim 13 is allowable.

In view of the foregoing amendments and remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are solicited.

The Commissioner is authorized to charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-1353.

Respectfully submitted,

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